Influence of Rainfall and Geographical Location on the Small Diameter Water Pipeline Failures

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Abstract: In this study, the influence of average annual rainfall on the failure of small diameter water pipeline from small to very large cities was investigated. Based on the data collected from a national survey, breakage in small diameter water pipeline was investigated. , Analyses of limited data using a nonlinear power relationship showed that the daily pipe breakage per unit length of water pipeline was related to the annual average rainfall and geographical location.

1. Introduction:

In recent years there have been increasing reports on water pipeline failures around the country. Water pipeline failures not only affect the water supply but also undermine the adjoining infrastructures and buildings. Hence there is need to investigate the various causes of the failures and also quantity the amount of potential water pipeline failures.

Small diameter water pipelines (< 20 inches) amount to over 90% of the entire water pipelines from small to very large cities. Since the pipelines are placed few feet below the ground, their durability will be very much affected by the weather condition and the location (latitude and longitude). In this study a survey was undertaken to collect information on the condition of water pipelines from cities that were well distributed geographically.

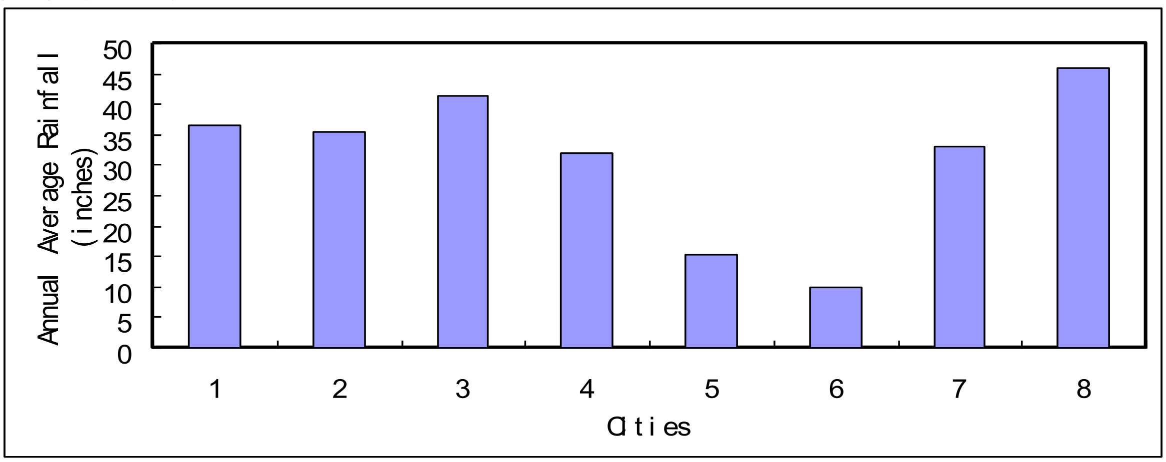

Figure 1 Annual Average Rainfall for Selected Cities in North America

2. Objectives:

The objective of this study was to investigate the relationship between geographical location, annual rainfall and small diameter water pipeline failures.

3. Analysis:

Information collected from eight cities is used in this analysis. In my model, pipeline breakage per mile was related to latitude and longitude and normal annual rainfall. a, b, c and d are constants.

$$\frac{PB}{L} = a \times [R]^{b} \times [N]^{c} \times [W]^{d} \qquad \text{...[1]}$$

where PB/L= average No. of breaks per day per mile of water pipeline
R= average annual rainfall
N= Latitude North
W= Longitude West

Initial investigation without location showed that the pipeline breakage showed that the pipeline breakage was inversely proportional to the rain fall, but comparing the prections (Figure 2) showed that the prediction was not good. Incorporating the location predicted the pipeline breakage per mile of water pipeline much better.

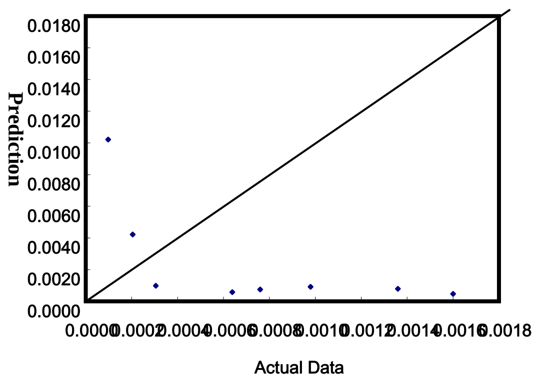

Figure 2 Model with only rainfall (a=1, b=-2, c=d=0)

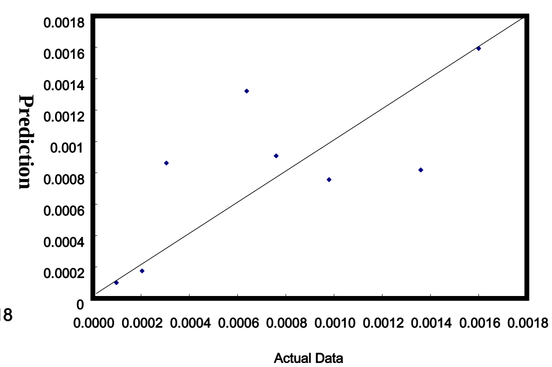

Figure 3 Model with rainfall and location (a=1.34, b=1.49, c=-1.43, d=-1.66)

5. Conclusion

The water pipeline breakage prediction was greatly improved when the locations were included in the analyses. From the nonlinear prediction model, the pipeline breakage was directly proportional to the annual rainfall and was also related to the geographical location.

6. Acknowledgements:

The study was sponsored by CIGMAT with funding from the City of Houston, Houston, Texas. Sponsor is not responsible for any of the conclusions.

7. References:

1. Normal monthly and annual precipitation ranged from 1961 to 1990 in selected cities in United States, http://www.allcountries.org/
2. National city water survey 2007, Richard F. Anderson, Mayors water council, the 75th United States conference of mayors.